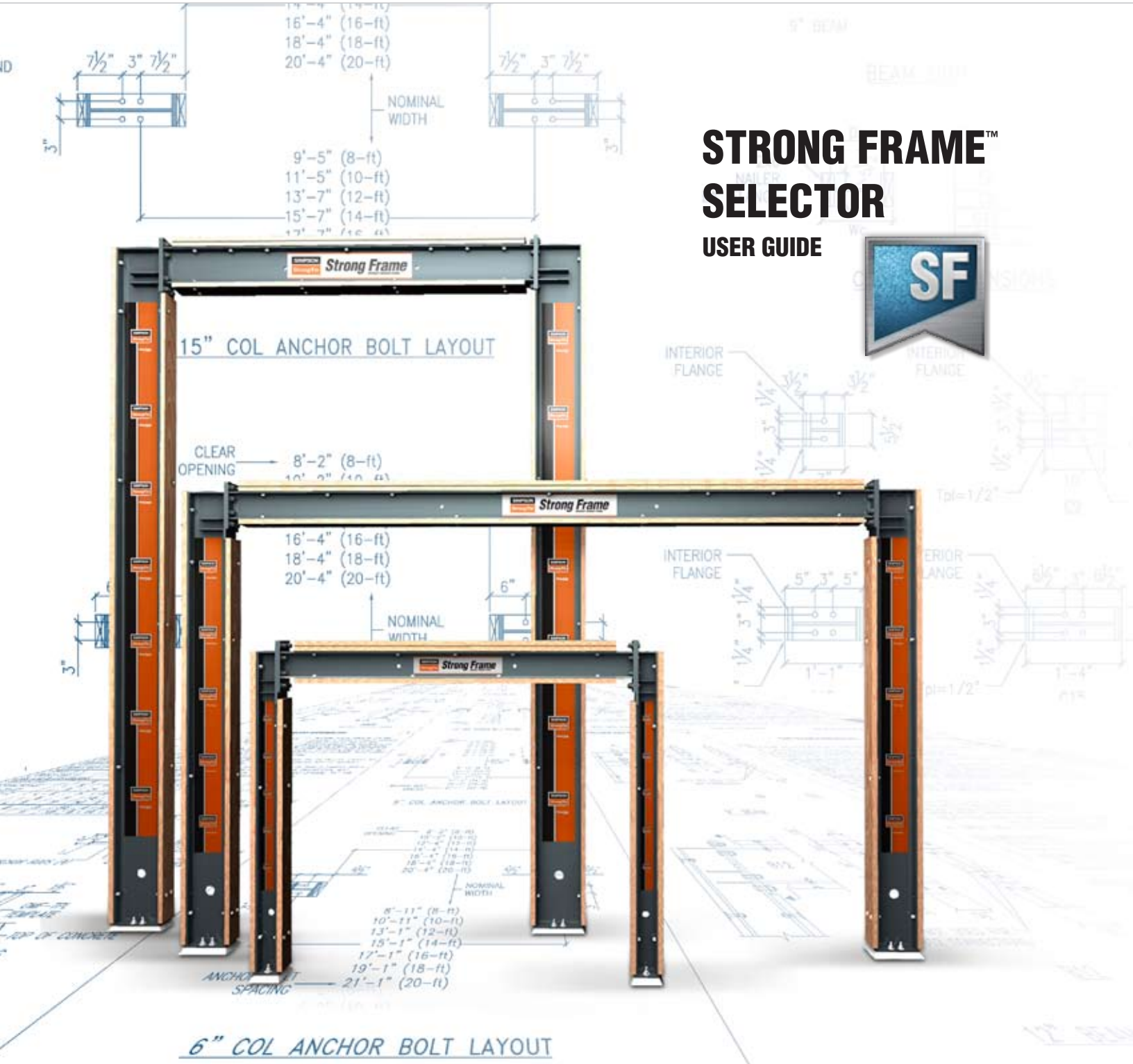
SIMPSON Strong-Tie®

STRONG FRAME™ SELECTOR

USER GUIDE



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GETTING STARTED

The Simpson Strong-Tie® Strong Frame™ Selector software is designed to help the Designer select an appropriate frame for their given geometry and loading. Only minimum input geometries are required for the software to select an appropriate frame for the available space. Based on input geometry, the Strong Frame Selector software will narrow down from the 368 available stock frames to a handful of possible solutions. If opening dimensions are outside of stock frame sizes, the Designer can enter their specific opening dimensions and the Strong Frame Selector will provide possible custom solutions.

An easy-to-use input screen and drop-down menus make it simple for the Designer to input lateral and gravity load information. Both wind and seismic loads can be entered and the Strong Frame Selector will determine possible frame sizes that meet the Designer's input requirements. Uniform, partial uniform as well as point loads can be placed anywhere along the span of the beam.

Once a frame size has been selected, anchorage design is as easy as picking the foundation type, concrete strength, concrete service condition (cracked or uncracked) and grade of anchor rod.

The .pdf output is in a concise format that contains only important design information. However, a detailed output is also available if desired.

Open the software by clicking on the Strong Frame Selector icon. Enter the required Job name, Frame ID and user information on the top of the screen. **Save** and **Save As** buttons will be active once all design criteria are entered and **Search** has been performed.

DESIGN CRITERIA

Following is a list of the input variables under the **Design Criteria** window on the Frame Design Tab:

Design Code: ASCE 7-05. Since both IBC 2006 and IBC 2009 references ASCE 7-05, the Strong Frame Selector load combinations are per ASCE 7-05.

ASD Seismic Load: Enter ASD seismic lateral load (in lbs.) resisted by the moment frame. This value should include any shear value from stories above. For any overturning forces imposed on top of the beam or column, see ASD Point Load section below. This seismic value must correspond to the seismic R-value entered (see **Seismic R-value** below).

Seismic R-Value: R-value is the response modification coefficient listed under Table 12.2-1 in ASCE 7-05.

- Use 3.5 if seismic load entered above is based on ordinary steel moment resisting frame; enter 6.5 if seismic load is based on light framed walls sheathed with wood structural panels rated for shear resistance.

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- Use 3.0 for design not specifically detailed for seismic resistance. There is also an option for less than 3.0 where other lateral systems limit the R value to less than 3.0.
- If R-value is entered as 6.5, the ASD seismic load used for analysis and design will be scaled up by the ratio of 6.5/3.5.

Seismic Drift Limit: The Designer has three drift limits to choose from: 0.015 hx, 0.020 hx and 0.025 hx, where hx is the story height. See ASCE 7-05 Table 12.12-1 for selecting the appropriate seismic drift limit.

Seismic S_{DS} value: Short period response acceleration value per ASCE 7-05 Equation 11.4-3

Importance Factor: Factor assigned to structure according to its occupancy category; please refer to ASCE 7-05 Section 11.5. Importance factor is used for calculating story drift per ASCE 7-05 Section 12.8.6. Corresponding ASD seismic load shall include this importance factor, see ASCE Section 12.8

Omega Factor: System over-strength factor from Table 12.2-1 of ASCE 7-05. This factor should correspond to R-value for the seismic force-resisting system. Per footnote g of Table 12.2-1, omega factor is permitted to be reduced by subtracting ½ for structures with flexible diaphragms.

Wind Load: Enter ASD wind load resisted by the moment frame. This value should include any shear value from stories above. For any overturning forces imposed on top of the beam or column, see **ASD Point Load** section below.

Wind Drift Limit: There are six wind drift limits the Designer can choose from. They are: no limit, hx/175, hx /250, hx/300, hx/350, hx/400; default is set to hx/250. The Designer must verify appropriate drift limit for their design requirements. Load combinations used for wind drift check are:

Combo	Load Calculation
20	D + 0.75 W + 0.75 L+ 0.75 Lr
21	D - 0.75 W + 0.75 L+ 0.75 Lr
22	D + 0.75 W + 0.75 L+ 0.75 S
23	D - 0.75 W + 0.75 L+ 0.75 S
24	D + 0.75 W + 0.75 L+ 0.75 R
25	D - 0.75 W + 0.75 L+ 0.75 R

Note that these combinations are slightly different that than proposed by ASCE 7-05 Chapter C, Appendix C: D + 0.5L + 0.7W.

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Beam Deflection Limits: For longer frames, beam deflection can become significant depending on the loading magnitude. There are three beam deflection limits the Designer can select, they are as follows:

Live load: L/600, L/480, L/360 [Default], L/240, L/180

Dead + Live Load: L/240 [Default], L/180, L/120

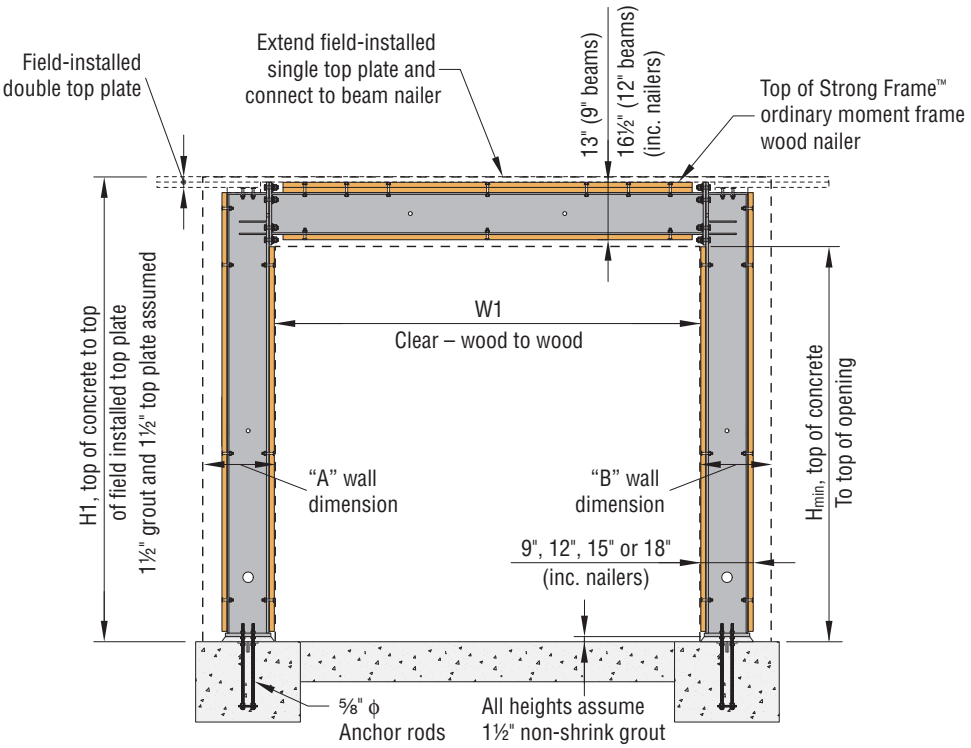
Snow or Wind Load: L/360 [Default], L/240, L/180, L/120

The Designer must verify beam deflection limits based on construction and loading type. Refer to IBC 2006 or IBC 2009 Table 1604.3 for appropriate beam deflection limits.

GEOMETRY

The Designer has the option to choose from a list of stock frames, with fixed W1 and H1 dimensions, by using the drop down buttons. If the W1 or H1 (see below) dimension does not fit within the Designer's geometry, custom frame design can be performed by entering the desired W1 and H1 values within Custom Frame Sizes.

Following is a list of input variables under the Geometry Section:


Field-installed double top plate
Extend field-installed single top plate and connect to beam nailer
13" (9" beams)
16½" (12" beams) (inc. nailers)
Top of Strong Frame™ ordinary moment frame wood nailer
H1, top of concrete to top of field installed top plate
1½" grout and 1½" top plate assumed
W1
Clear – wood to wood
"A" wall dimension
"B" wall dimension
9", 12", 15" or 18" (inc. nailers)
Hmin, top of concrete To top of opening
⅝" ϕ Anchor rods
All heights assume 1½" non-shrink grout

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Stock Frames:

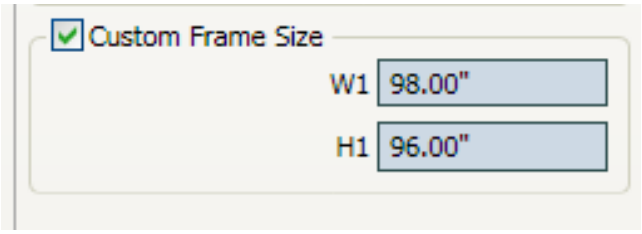
- **W1 –** Clear opening width from the inside face of 2x wood nailers for each column.
- **H1 –** Dimension from top of concrete to top of the field installed top plate. The dimension includes 1-1/2" for field-installed top plate and 1-1/2" for non-shrink grout under the base plate.
- **Hmin –** Clear opening height from top of concrete to the bottom face of the beam-bottom nailer. Dimensional difference between H1 and Hmin is used by the Strong Frame Selector to calculate possible beam sizes.

For garage-front applications where the steel frame bears on top of a concrete curb and the clear opening height is measured from the top of the concrete slab to the bottom of the steel beam nailer, Hmin should be adjusted to exclude the curb height.

- **"A" Wall Dimension –** Space available for the left column. It is dimensioned from the interior face of the inside nailer of the left column to the edge of the next opening/end of wall.
- **"B" Wall Dimension –** Space available for the right column. It is dimensioned from the interior face of the inside nailer of the right column to the edge of next opening/end of wall. Minimum of A and B wall dimensions is used by the Strong Frame Selector software to calculate possible column sizes.

Column dimensions including wood nailers are 9" for C6, 12" for C9, 15" for C12 and 18" for C15. For example when 12" is entered for both A and B wall dimensions, only frames using the C6 and C9 columns will be shown on the list of possible solutions.

Custom Frames:



W1, H1, Hmin, A Wall Dimension and **B Wall Dimension** are all defined the same as for stock frames, except **W1** and **H1** dimensions can be input by the Designer. Minimum and maximum **W1** dimension allowed are 6'-0" (72") and 20'-4" (244"). Minimum and maximum **H1** dimension allowed are 7'-2½" (86 ½") and 21'- 1" (253").

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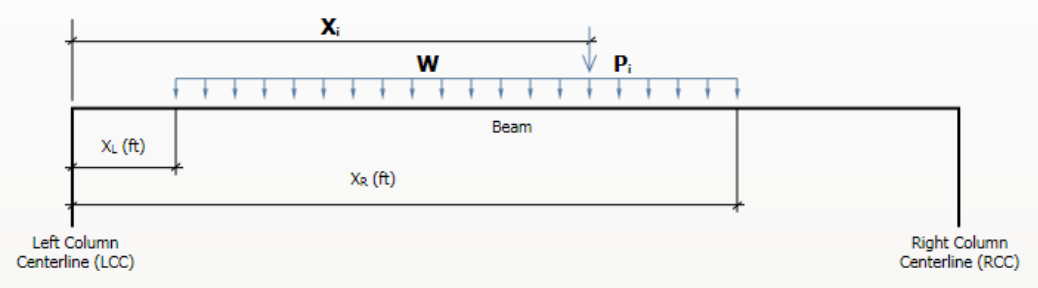
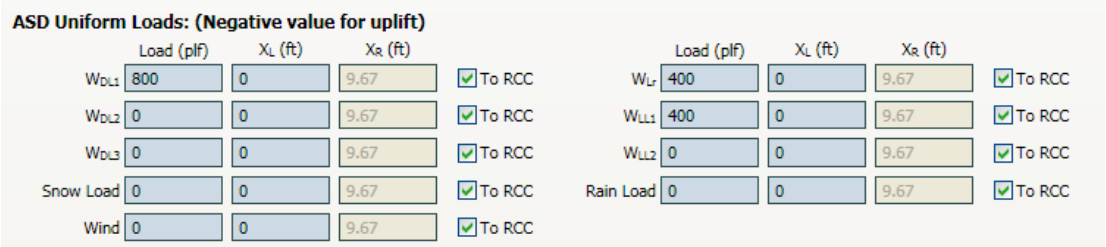
VERTICAL LOAD

Vertical loads are input in the **Load Distribution** window located under the **Design Criteria** window. Sign convention for loading is positive in the gravity direction and negative for uplift. Default values are 800 plf Dead Load, 400 plf Live Load and 400 plf Roof Live Load. Uniform loads are in pounds per linear foot, and may be the full width of the frame or may be partial loads. 7 basic load cases can be entered into the Strong Frame Selector software as follows: dead load (DL), live load (LL), roof live load (RLL), Snow, Rain, Wind and Seismic.

The loading is represented graphically by the following diagram:



ASD Uniform Loads: The Designer can input uniform loads for W_{DL}, W_{LL}, W_{L}, Snow, Rain and Wind. Partial uniform loads can start and end anywhere within the beam span. The dimensions X_L and X_R are the distance from the centerline of the left column to the start and end of the partial uniform load, respectively. Strong Frame Selector will ignore any loads past the end of the beam. Click on "To RCC" to load the beam to the right column centerline


ASD Uniform Loads: (Negative value for uplift)
Load (plf)
XL (ft)
XR (ft)
WDL1 800 0 9.67 To RCC
WDL2 0 0 9.67 To RCC
WDL3 0 0 9.67 To RCC
Snow Load 0 0 9.67 To RCC
Wind 0 0 9.67 To RCC
Load (plf)
XL (ft)
XR (ft)
WL 400 0 9.67 To RCC
WLL1 400 0 9.67 To RCC
WLL2 0 0 9.67 To RCC
Rain Load 0 0 9.67 To RCC

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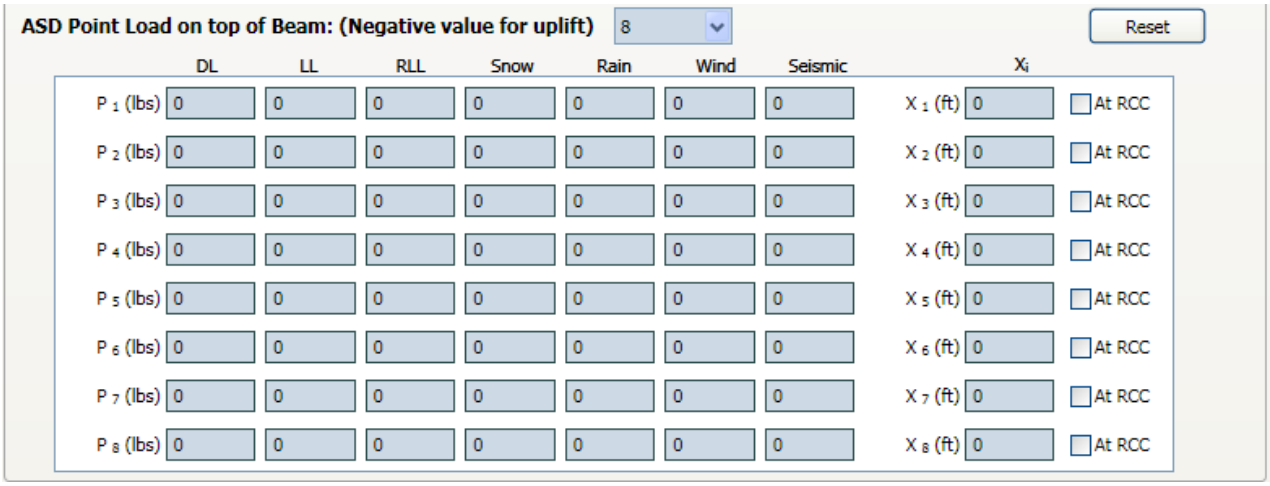
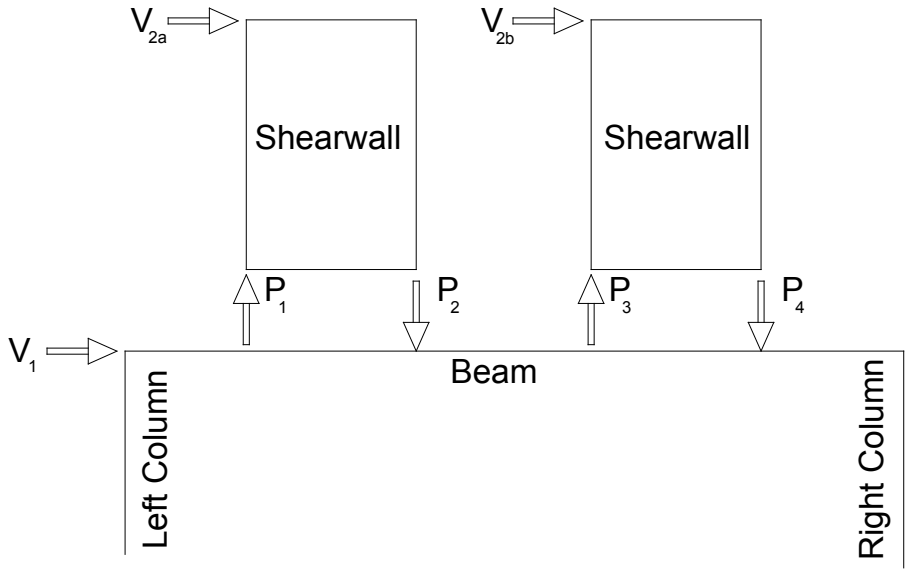
ASD Point Loads: Up to eight point loads can be entered for each of the seven basic load cases. Point loads are specified in lbs. followed by the distance from the centerline of the left column. For seismic point reactions within the beam, the Designer must factor the seismic point loads with Ωo.



Point loads due to wind or seismic from shearwall reactions above the moment frame must be consistent with the direction of the lateral load. For example, P1 and P3 in the figure below shall be entered with a negative value for uplift. The selector software will switch the direction of P1 and P3 to positive and P2 and P4 to negative and V1 to negative thru load combinations so the Designer do not have to do two designs by switching the load directions. See **Load Combinations** section for more information regarding load combination and direction of lateral loads.



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LOAD COMBINATIONS

The seven basic load cases defined above (DL, LL, RLL, Rain, Snow, Wind, and Seismic) are used for combining loads Per ASCE7-05. The basic load cases and load combinations are summarized in the tables below:

Combo	Load Combinations	
1	D	Load Cases
2	L	
3	Lr	
4	S	
5	R	
6	W	
7	E	
8	D	ASD
9	D+ L	
10	D + Lr	
11	D + S	
12	D + R	
13	D + 0.75 L+ 0.75 Lr	
14	D + 0.75 L+ 0.75 S	
15	D + 0.75 L+ 0.75 R	
16	D + W	
17	D - W	
18	(1.0 + 0.14 SDS) D + 0.7 E	
19	(1.0 + 0.14 SDS) D - 0.7 E	
20	D + 0.75 W + 0.75 L+ 0.75 Lr	
21	D - 0.75 W + 0.75 L+ 0.75 Lr	
22	D + 0.75 W + 0.75 L+ 0.75 S	
23	D - 0.75 W + 0.75 L+ 0.75 S	
24	D + 0.75 W + 0.75 L+ 0.75 R	
25	D - 0.75 W + 0.75 L+ 0.75 R	
26	(1.0 + 0.105 S_{ns}) D + 0.525 E + 0.75 L + 0.75 Lr	
27	(1.0 + 0.105 S_{ns}) D - 0.525 E + 0.75 L + 0.75 Lr	
28	(1.0 + 0.105 S_{ns}) D + 0.525 E + 0.75 L + 0.75 S	
29	(1.0 + 0.105 S_{ns}) D - 0.525 E + 0.75 L + 0.75 S	
30	(1.0 + 0.105 S_{ns}) D + 0.525 E + 0.75 L + 0.75 R	
31	(1.0 + 0.105 S_{ns}) D - 0.525 E + 0.75 L + 0.75 R	
32	0.6 D + W	
33	0.6 D - W	
34	(0.6 - 0.14 S_{ns}) D + 0.7 E	
35	(0.6 - 0.14 S_{ns}) D - 0.7 E	
36	1.4 D	LRFD
37	1.2 D + 1.6 L + 0.5 Lr	
38	1.2 D + 1.6 L + 0.5 S	
39	1.2 D + 1.6 L + 0.5 R	
40	1.2 D + 1.6 Lr + 0.5 L	
41	1.2 D + 1.6 Lr + 0.8 W	
42	1.2 D + 1.6 Lr - 0.8 W	
43	1.2 D + 1.6 S + 0.5 L	
44	1.2 D + 1.6 S + 0.8 W	
45	1.2 D + 1.6 S - 0.8 W	
46	1.2 D + 1.6 R + 0.5 L	
47	1.2 D + 1.6 R + 0.8 W	
48	1.2 D + 1.6 R - 0.8 W	
49	1.2 D + 1.6 W + 0.5 L + 0.5 Lr	
50	1.2 D - 1.6 W + 0.5 L + 0.5 Lr	
51	1.2 D + 1.6 W + 0.5 L + 0.5 S	
52	1.2 D - 1.6 W + 0.5 L + 0.5 S	
53	1.2 D + 1.6 W + 0.5 L + 0.5 R	
54	1.2 D - 1.6 W + 0.5 L + 0.5 R	
55	(1.2 + 0.2 S_{ns})D + E + 0.5 L + 0.2 S	
56	(1.2 + 0.2 S_{ns})D - E + 0.5 L + 0.2 S	
57	0.9 D + 1.6 W	
58	0.9 D - 1.6 W	
59	(0.9 - 0.2 S_{ns}) D + E	
60	(0.9 - 0.2 S_{ns}) D - E	
61	(1.2 + 0.2 S_{ns})D + E + 0.5L + 0.2S	
62	(1.2 + 0.2 S_{ns})D - E + 0.5L + 0.2S	
63	(0.9 - 0.2 S_{ns}) D + E	
64	(0.9 - 0.2 S_{ns}) D - E	

For load combinations 8 to 60, a minimum lateral load, Ni = Maximum [75 lbs., 0.2 x Maximum (wind or seismic)] is added to the combinations. If Ni is greater than the input lateral load (i.e Ni = 0.2 x seismic load is greater than wind load), the software will replace that lateral load in that combination. This is similar to the 0.002Yi requirement by AISC 360-05, Section C2a.3. Load combinations 61 to 64 are use for the base plate and anchorage design as required by AISC 341-05 Section 8.5

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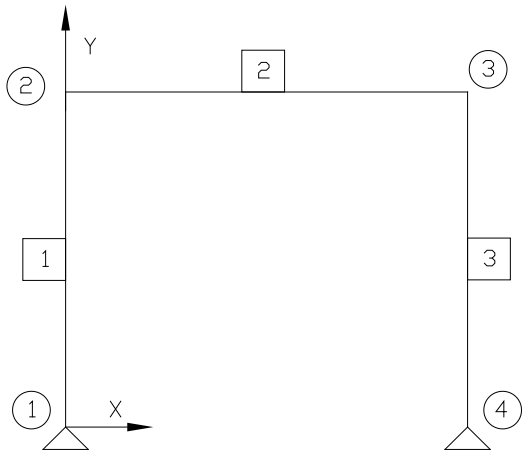
ANALYSIS

Analysis for the Strong Frame Selector software is based on the stiffness method. For each element (beam and columns), a stiffness matrix is determined and then assembled into a combined global stiffness matrix. After applying boundary conditions (pinned based columns), the Strong Frame Selector solves for the overall displacement matrix. From the displacement matrix, member end forces are determined for each of the elements.

The stiffness matrix for each element is based on centerline-to-centerline dimensions with the Euler-Bernoulli beam model (shear deformations included). Both large (P-Δ) and small (P-δ) P-Delta are considered in the analysis and design by the use of the geometry stiffness matrix method for P-Δ and AISC B1 factor for P-δ.

Member internal forces are determined by sub-dividing each element into 100 segments. Shear, axial, moment as well as deflection are calculated along the 101 points for each element.



Please see frame analysis verifications under the **Resources** tab.

SIGN CONVENTIONS

Default coordinate system is the 2D Cartesian coordinate system with x-axis being in the horizontal direction and y-axis being in the vertical direction. Positive y-direction is up (uniform and point loads as defined in the previous section follows the same convention, except a negative sign is automatically added to the user input values for point and uniform loads so Designers do not have to type in the (-) sign for gravity loading).

Member moment is outputted with positive values on the tension side and negative values on the compression side. Positive column reaction axial values indicate compression where as negative axial reaction values indicate tension. For beam deflection in the y-axis, negative values indicate beam is deflecting down (gravity direction), where as positive values indicate the beam is deflecting up.

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MEMBER DESIGN

Member design is in accordance with the AISC Steel Construction Manual (AISC 360-05). Design for beam flexure is in accordance with sections F.1 and F.2 of the manual. Due to the different flange thicknesses, column flexure design is in accordance with section F.4. Sections E.1 to E.3 are used for beam compression design. Section E.4 is used for column compression design. Combined flexural and axial design for beam and columns are in accordance with Chapter H. Member design for shear is in accordance with Chapter G. The maximum demand-to-capacity ratio (DCR) for all member design is limited to 1.01. Same DCR ratio applies to wind and seismic deflection limits as well as connection design and anchorage design (see following sections).

CONNECTION DESIGN

End plate moment connection capacities are calculated based on AISC Design Guides #4 and #16. These capacities are pre-calculated based on the beam and column connection geometries. Capacity values are used to compare to the force demand for each of the LRFD design combinations. These capacity calculations can be viewed and printed under the **Resource** Tab located on main tool bar of the Selector Software.

Base-plate capacities are calculated based on AISC Design Guide #1. These capacities are pre-calculated based on the column geometry. Base plate tension, shear and axial capacities are used in the Strong Frame Selector program to compare to the force demand for each of the LRFD design combinations. These capacity calculations can be viewed and printed under the **Resource** Tab located on main tool bar of the Selector software.

Beam top nailer capacity calculations can also be viewed and printed under the **Resource** Tab located on main tool bar of the Selector software.

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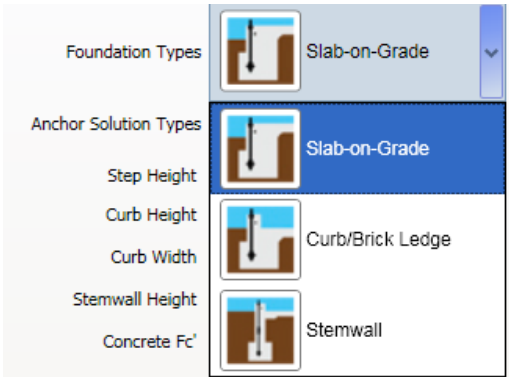
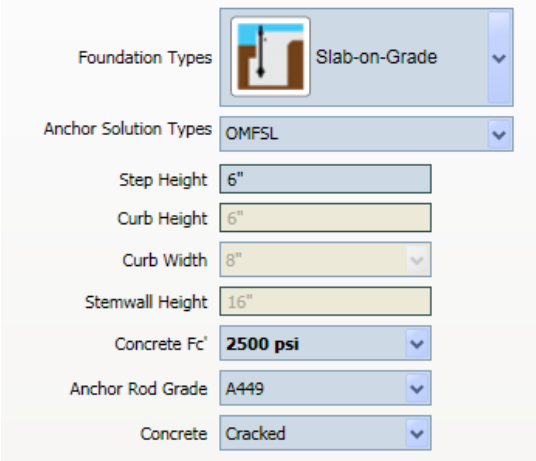
ANCHORAGE SOLUTIONS

After a frame model has been selected, the **Anchorage Design** tab becomes active and the Designer can chose anchorage solutions based on **Foundation Type**. The three foundation types are described below and are selected from a drop down menu:



For **slab-on-grade foundation types**, there are two solutions the Designer can choose from; they are **OMFSL** and **OMFAB with hairpins**.

Input fields required for the OMFSL and OMFAB with hairpins are:



Step Height: Height from top of concrete footing to top of concrete slab. This dimension is used for determining the length of anchor rod required for anchorage.

Concrete Strength (fc'): The Designer can choose 2500 psi [default], 3000 psi, 4000 psi or 4500 psi as the concrete strength. The concrete strength is used for determining the anchorage tension and shear capacities.

Anchor Rod Grade: Two anchor rod grades are available to the Designer, either F1554 Gr. 36 or A449 [default]. Anchorage solution using A449 include "HS" in their designation to denote high strength.

Concrete (service condition): The Designer can choose either cracked [default] or non-cracked as the service concrete condition. See ACI 318 appendix D for the different reductions factors associated with cracked or non-cracked concrete.

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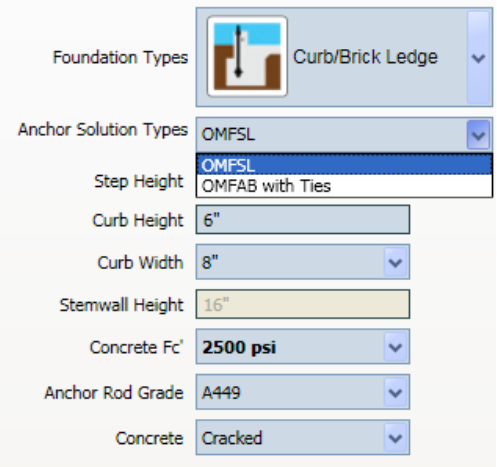
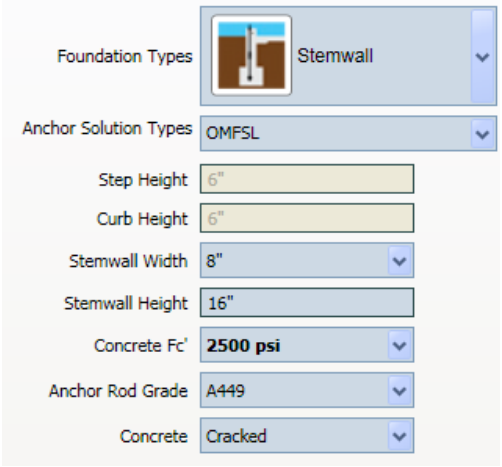
For **Curb/Brick Ledge foundation types**, two solutions are available for the Designer. They are **OMFSL** and **OMFAB with Ties**. Input fields for these solutions are similar to the Slab-on-Grade solutions, except **Curb Height** is required instead of **Step Height**. One additional input is the **Curb Width**. Under this drop down box, the Designer can choose either an 8" [default], 10",or 12" wide concrete curb.



If small end distances are required/desired, the **OMFAB with Ties** is the best option. However, it has a minimum 2-1/2" edge distance from the centerline of the outer most anchor bolt to the edge of concrete.

For **Stemwall Foundation Types**, only the **OMFSL** solution is available to the Designer. However, this requires Designer design wall reinforcing to transfer forces from the base of the column down to the foundation. Capacity of the anchor rods, shear lug, hairpin, ties and concrete are included in the solution PDF output. Anchorage force demands are also summarized in the solution so the Designer can perform their own anchorage design.



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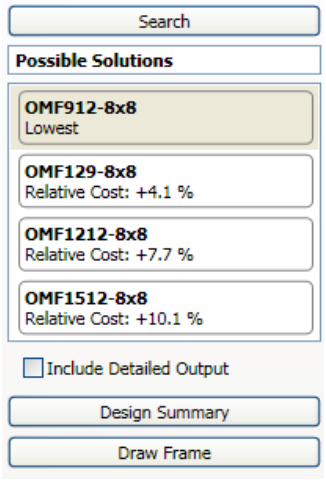
OUTPUT

FRAME PDF OUTPUT

Once the list of **Possible Solutions** appears after the frame analysis/design, the Designer has the option to generate a **Design Summary** in .pdf format. This .pdf file contains a summary of the design input parameters entered by the Designer as well as the loading information on the first page.



On the second page, all the relevant demand capacity ratios are presented for the frame design followed by the governing design forces. Page 3 summarizes the frame design with all the frame geometry dimensions. Note that the final W1 and W2 dimensions depend on the foundation anchorage solution. The Designer must refer to the Anchorage output for the final W1 and W2 dimensions where additional end distances might be required for anchorage design.

If a more detailed output is desired for the frame design, the Designer has the option to view/print a more detailed output by clicking on the check box labeled **Include Detailed Output**.

Detailed output includes the Design Summary described above followed by member properties, frame analysis geometries, member nodal displacements, beam forces, column forces, beam member design, column member design from all the LRFD design load combinations and ASD column reaction forces for the seven basic load cases.

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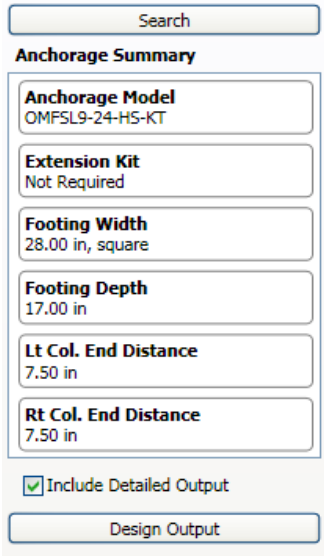
ANCHORAGE PDF OUTPUT

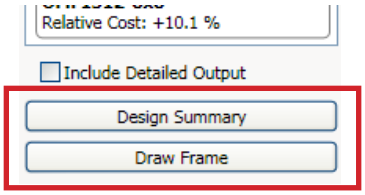
Similar to the Frame .pdf output, anchorage design output can be generated by the push of the **Design Output** button in the Anchorage Design tab. The anchorage design .pdf file summarizes the anchorage model, footing width and footing depth required for anchorage as well as end distance required from the centerline of the nearest anchor bolt to the edge/end of concrete. In addition anchorage design forces and anchorage capacities are summarized. On the last page of the PDF file, ASD foundation forces for both left and right column are output to aid the Designer in their foundation design.

When Include Detailed Output is selected, detailed output from Frame Design section will be output followed by the anchorage information.



DRAW FRAME

In addition to PDF outputs, the Designer can also generate an AutoCAD elevation of the selected frame by clicking the **Draw Frame** button located under the **Design Summary** button. The elevation is drawn to scale so Designers can simply insert the frame elevation into their drawing.



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